Impulse

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Impulse

Recovery for a new age

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Industrial design capstone booklet
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Section

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Section

01

Research

01

Mission Statement

To better physical therapists and their patients by implementing a system that achieves harmony and compliance through a discrete product.

01

Problem Statement

Sports and injuries go hand in hand and any serious athlete knows that physical therapy and structured recovery are necessary steps if they hope to return to their sport. Currently there are many discrepancies in the percieved level of care patients recieve during physical therapy, and the industry has identified two major factors for this.

The first issue is identified as non-compliance with at home exercise programs, the other point is that patients are receiving generic exercise plans that do not address their unique circumstances. Professionals have the affordance of their entire personal therapy staff at their immediate care. So how can we make the most of the care that atheltes are receiving?

The post injury market for a product or device that can aid athletes in recovery would benefit from:

"Guidelines of restricted and encouraged movement."
"How they move, and the mechanics of alignment."
(Dr. Coty Thomas Jefferson University Center City)

"Biometrics of movement for improvement across time up to return to original activity."
"Important to monitor how we land on our feet after an injury."
"Physical performance tests at incremental periods with potential to relay data from these at home tests to the practitioner to lessen need for in office tests."
(Dr. Spinelli Thomas Jefferson University Center City)

01

P.T. for Athletes

With Physical Therapy there are four stages; fix, train, strengthen, and progress. The initial step for an injured athlete is to address the injury and define the plan for recovery. Next the patient works to regain movement and functionality of particular body parts. Thirdly is the strenghtening stage where patients are re-establishing muscular strength and endurance. Lastly, the progress stage is where the body is retrained to perform higher function and complex physical activities that pertain to the athletes sport. This final stage is where most patients unfortunately do not have the direct support of the Physical Therapist in person and as a result are at greater risk of re-injuring themselves or failing to adhere to their recovery plan.

"2015 saw 8.6 million americans experience a sport related injury"

(U.S Department of Health and Safety)

493,011

488,123

399,873

01

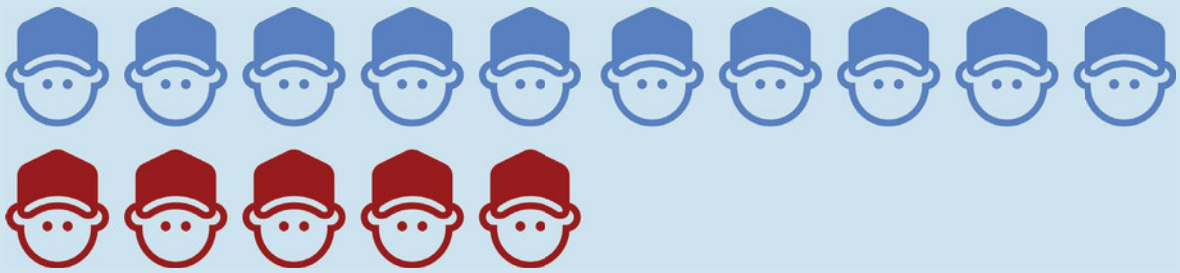
Target User

Athletes have to go out of their way to recieve physical therapy, and for many this is a time consuming and expense endeaver, but they do it because they want to return to their sport. The desire to get better and improve ones performance is a universal mindset and many amateur and semi-pro athletes could benefit from a way of maximizing their physical therapy and limiting their down time so that they can get back to training and competing.

As the care provider, Physical Therapists want their clients to get the most out of their treatment, but they cannot be there every hour of everyday for the people they care for. This is a big limiting factor for athletes because without proper guidance their treatment is slower and their recovery takes longer.

Information is a crucial part in the recovery process as the Physical Therapist needs to be able to make informed adjustments to a patients regiment and without physical monitoring their progress they have to rely on their patients insight and routine checkups to make decisions on their progress. This means that an athlete might not be doing the perscribed excersises but could tell their practictioner they are, or on the flip side, an athlete might be closely following their recovery plan but their PT does not meet with them enought to keep their schedule in line with their progress.

"On average a sports Physical Therapist will see between 10 and 15 clients in an 8 hour day."



01

Existing Product Market

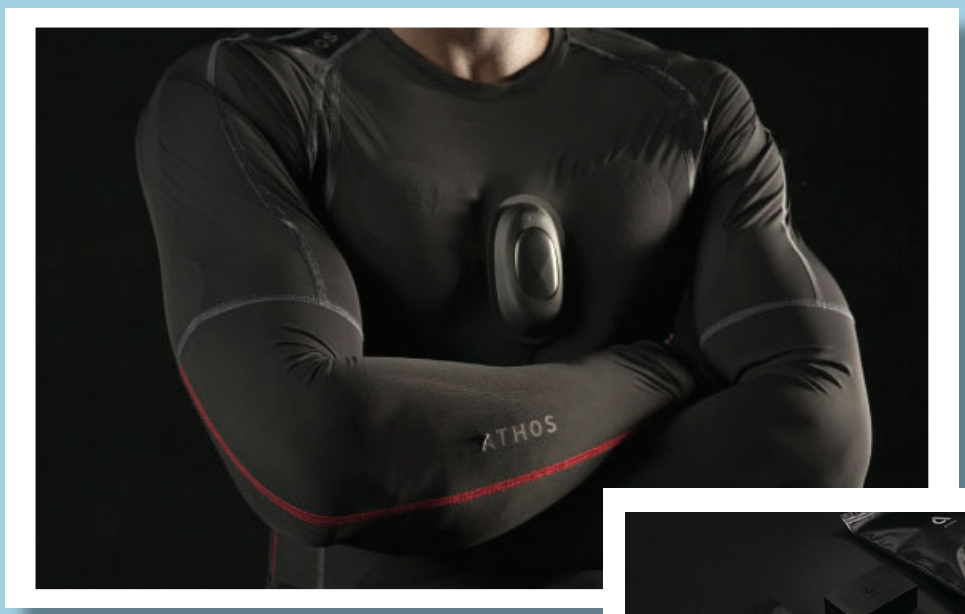
Motion tracking allows the user to physically copy motions and know whenthey have achieved the proper form for each exercise. This system gives physical therapy patients in specific a concrete target to aim for when doing their at home excercises.

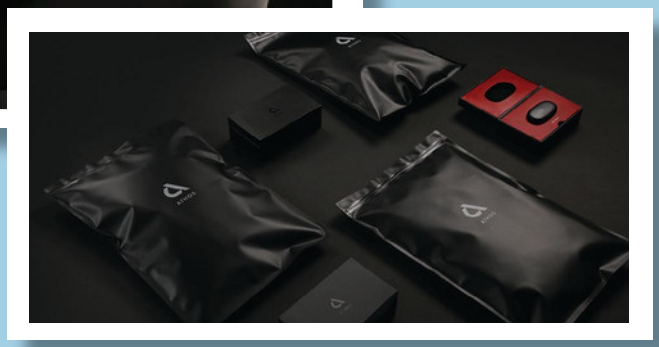
Some devices such as Valedo are consumer specific products that provide a generic excercises for mobility and stability training, but go as far as provide a feature where the user can send their physical therapist their training progress for critical evaluation.

Biometrics are an increasingly actionable set of information for athletes who strive to maximize their training. Being able to monior muscle power and heart rates allow training sessions to stay in the optimal range wfor longer as well as balancing muscles groups.

Athos is a biometric garment set for athletes trying to monitor and maximize their training sessions. The user gets real time visualization of their heart rate and muscle activity thanks to embeded EMG (electromyography)sensors.


Hocoma
Hocoma
Hocoma


ATHOS



01

Market Opportunity

Currently the motion tracking market is comprised of consumer grade products that loosly offer motion tracking with visual goals and feedback. For biometric wearables, companies target athletes who have a support infastructure such as a personal trainer or team trainer. While allow the wearer to connect their phone for some information, it really is more beneficial for their trainers to structure their workouts and technique to maximize the workout.

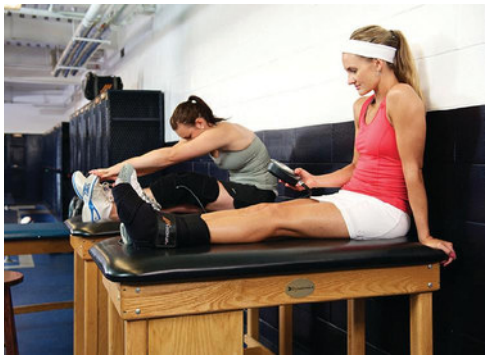
To find the right system for athletes going through Physical Therapy, We weighed out the strengths and weaknesses of each of the monitoring systems. For the product to help maximize an athlete's physical therapy it needs to guide the user through their recovery plan, while communicating back to the practitioner real time updates of their progress. The opportunity here is that by combining the two technologies, we can provide athletes with real time- performance guidance clothing that does more for them during physical therapy, but continues to structure their training as they return to their sports.

	Feed back	Motion Capture	Real Time
ATHOS	✓	✗	✗
valedo	✓	✓	✗
SPT	✗	✗	✓

01

Athlete's Vision

From the young athletes we had talked with, it was apparent that many of our demographic had issues adhering with their recovery routine. Most of the time they simply couldn't remember all the instructions given to them from their PT and so they weren't effectively using their time in-between sessions. Others complained about their scheduling being too easy or too hard and that they could not communicate this with their practitioner. We found that athletes are always pushing to get back from and injury to the point where some prefer to cover up their symptoms rather that address them.



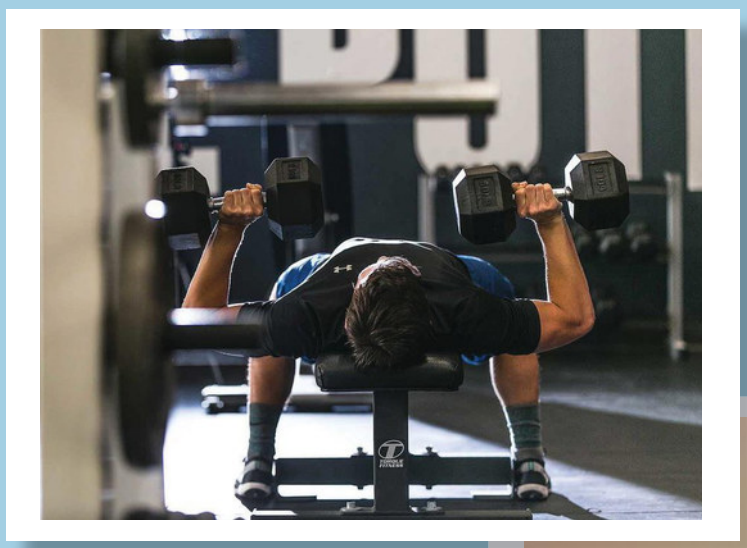
Physical Therapist's Insight

We interviewed Physical Therapy faculty at Jefferson University Center City, to understand their impression and experience utilizing different tools with their patients. They expressed an optimism for smart wearables as the future "tool of the trade" as it can act as a mediator between practitioner and their client. Their main point was that their athletes are highly driven to succeed and already seek out cutting edge tools to improve their game. The barrier athletes face when it comes to Physical Therapy is their desire to get back to the game can sometime blind them from the natural signs their body is giving them.

01

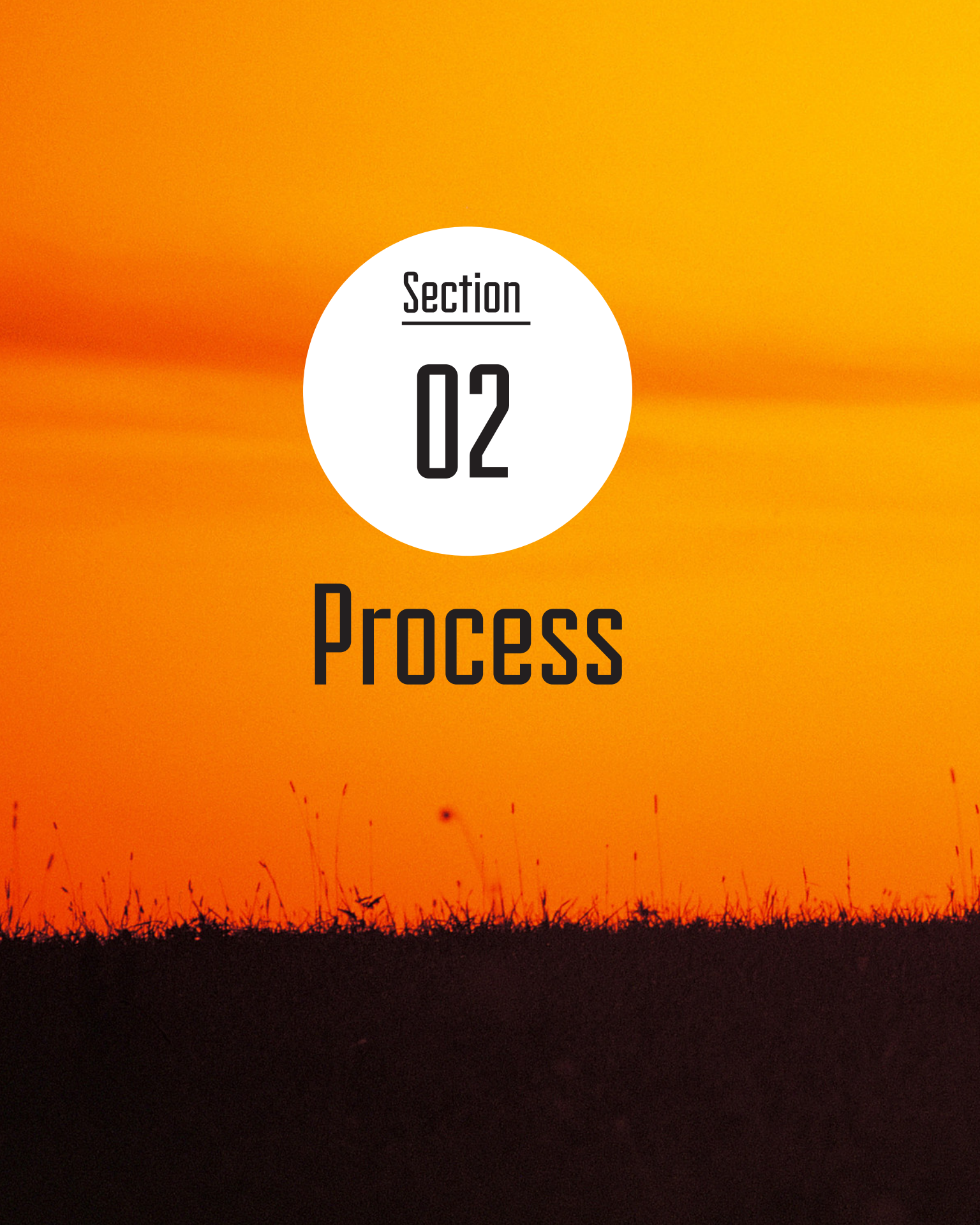
During Physical Therapy

Our product would provide both the user and practitioner with a deeper level of understanding. Physical feedback would let the wearer know if they are achieving the specific goals of each exercise session, while also alerting them if they were doing too much and at risk of reinjuring themselves. The Physical Therapist's benefit from having a second set of eyes to monitor their patients remotely and use this to actively update their regiment. The goal is to decrease athlete recovery times and make the most out of the care from the PT.



During Training

With the combined sensor monitoring and market opportunity, the products lifespan can be extended past physical therapy and into the athlete's training. Going above just biometrics of existing products, the motion tracking adds a second dimension to their training so that their performance potential can be maxed out. Specific sport training requires a balance of precision and strength, similar to videotaping a session. Our product provides that game tape analysis of the workout so that athletes can balance their muscle training and maximize their movements for optimal performance.



Section

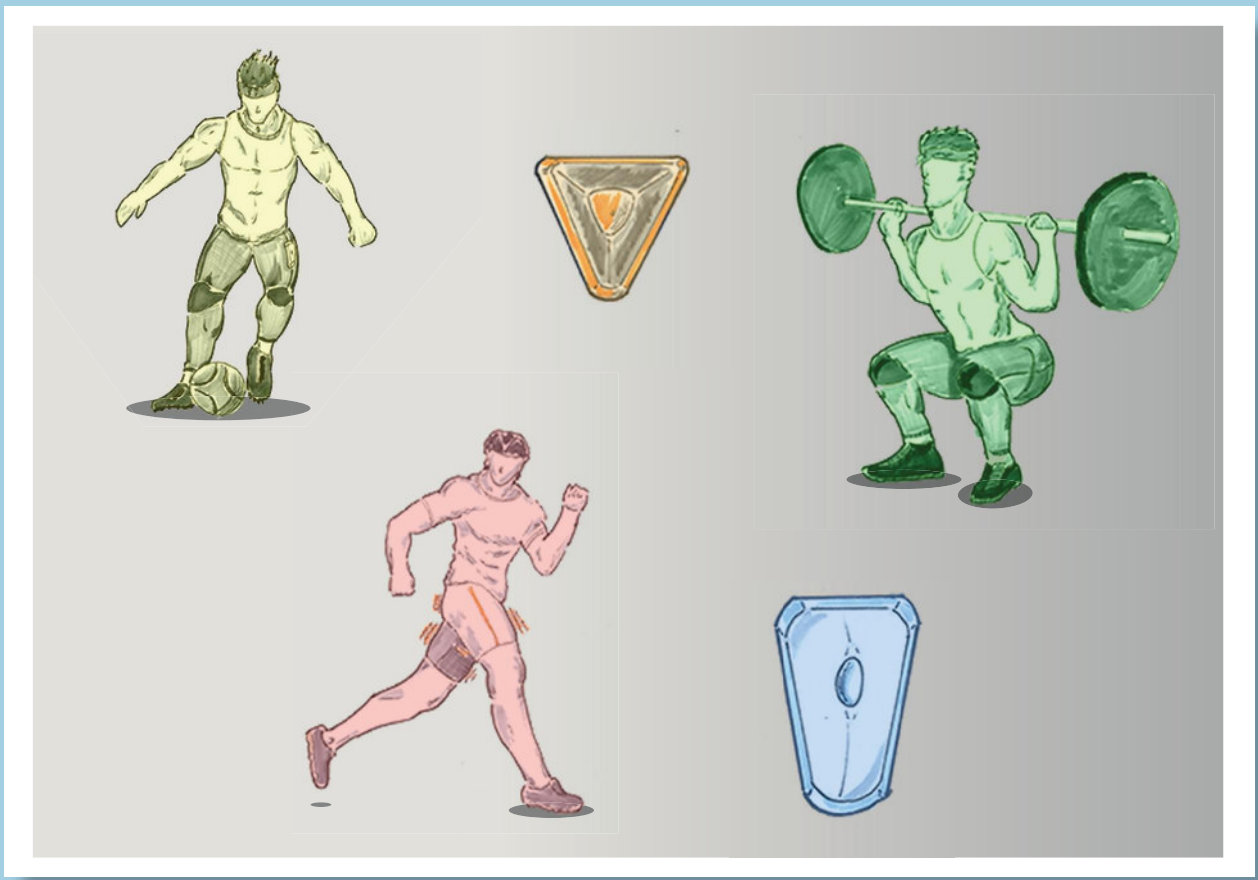
02

Process

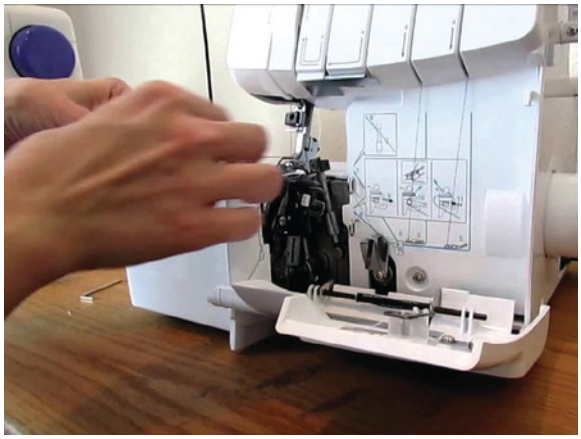
02

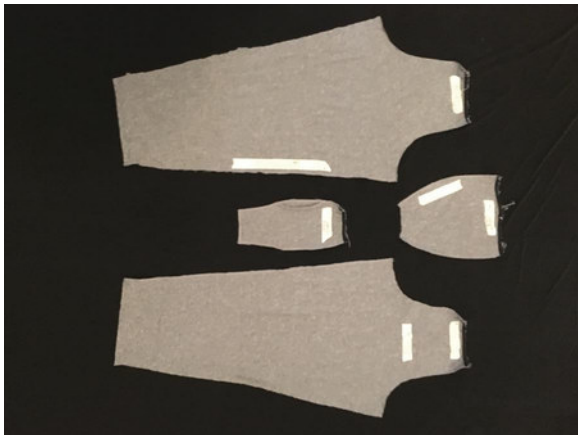
Early Development

At the beginning of our journey we had a good idea of the current market and what processes needed to be handled to make our project tangible. A lot of dismantling, research and professional help went into the re-creation of the separate parts of the project. The task was daunting, but through every road block and "Eureka" moment we managed to come back with a new and better understanding through every iteration.

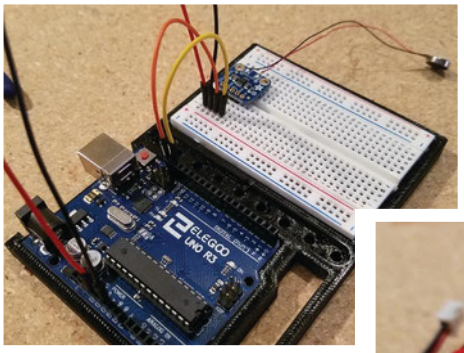


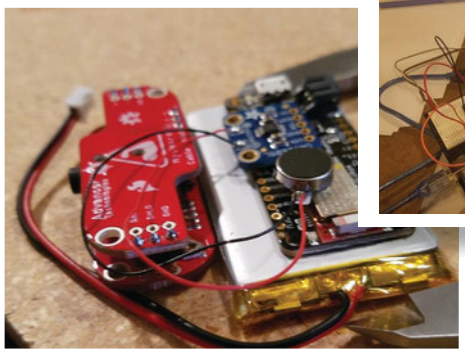
With the garment we had to start from scratch. Each round of production made small steps forward as we not only were learning. Stencils were new, the surger was new, and the material was its own challenge. Little by little we progressed and took insight from our resources and existing products to make the garment better and more deliberate.

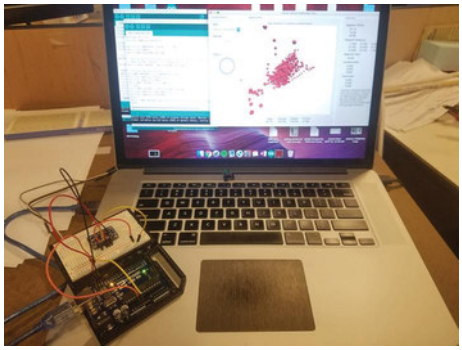




The technology was another challenge with neither of us having any arduino know how. The first step was identifying all the components in our research products that worked to track motion and the biometrics. Next was to identify how these parts would translate into our design and lastly was simply doing.



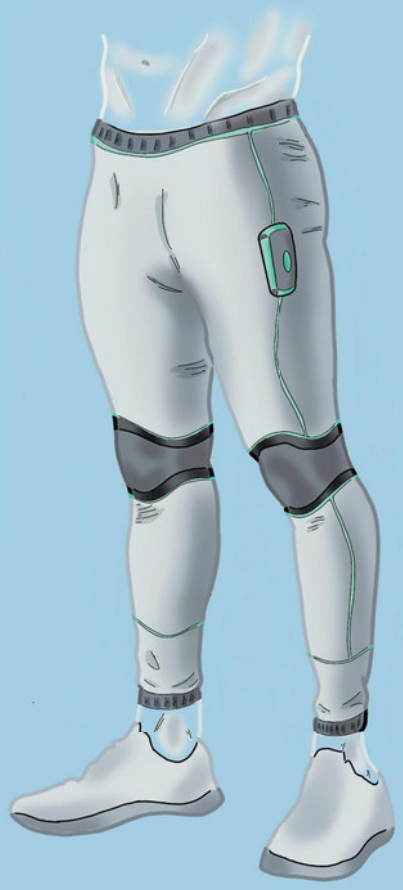




02

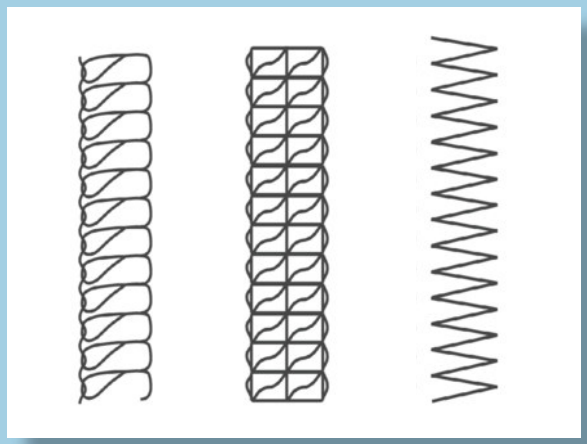
Stage 1: Design & Construction

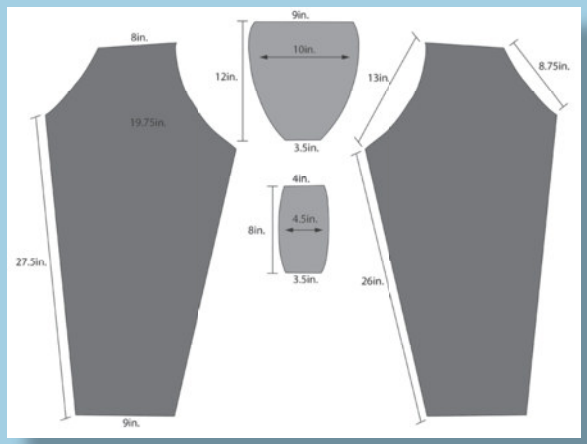
Starting on the garment had us de-construct existing products so that we could create our own pattern and design. Special consideration for where our technology had to fit was taken into account when patterning and sewing our initial models. In order to get certain results, special methods had to be achieved in order to get the right results.



The design of our garment came from looking at trending base layers already in the market and basing our aesthetics and style on those while also keeping with manufacturing constraints. We started by doing the standard four piece construction which entailed two legs, a crotch and rear piece and built off of that in generations succeeding. Color was also a big deal, due to the market for base layers like this being flamboyant and flashy we decided on a more reserved color pallet.This decision allowed the technology to take the lead over a saturated color.

Our initial pattern had to be modified multiple times in order for the sizing to fit right on a persons body. Difficulties with this stemmed from the material being stretchy which would contort and stretch in different directions if it did not fit correctly. Two seperate machines had to be utilizied in the construction of this garment. A standard sewing machine and a flatlocking machine. The three stitched predominately sed in the process of making the article are a 3 thread overlock, a 4 thread overlock and a standard zig-zag stitch.





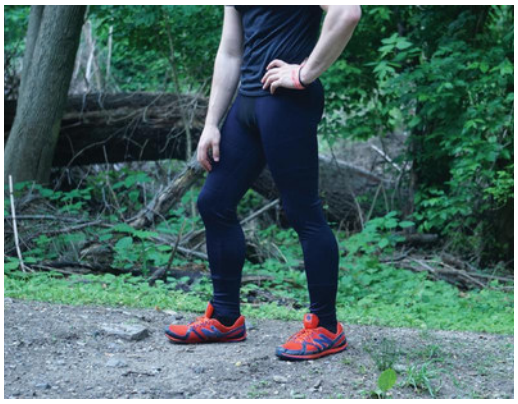
02

Stage 2: Preliminary Prototypes

In this stage we had to create prototypes that would be comparable in fit and sizing to current leggings in the market. The materials we chose for this stage were wicking fabrics that were 10% spandex and 90% polyester. In order to get a proper fit, we had to pattern different panels of the garment and measure accordingly.

The first couple of pairs of leggings were a challenge. We sought to make our own pair of leggings taking reference and inspiration from other companies. Stretch material is its own challenge, you would think there would be a lot of room for error when the material can expand, however a lot of the material in the first stages would contort and bend if the panels were not patterned or lined up correctly.

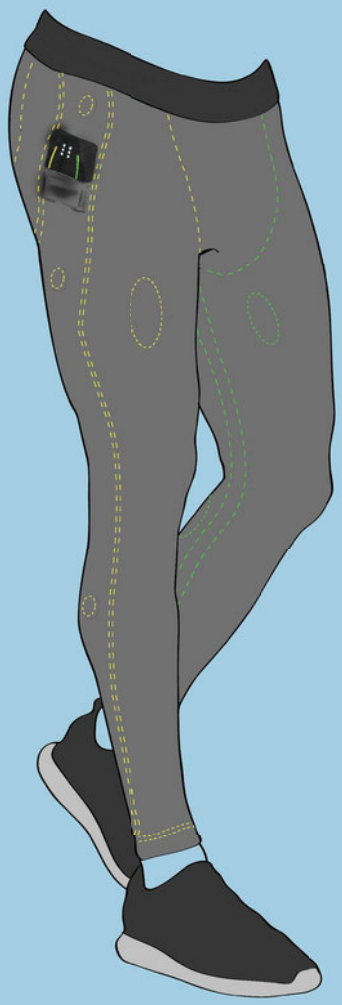
Continueing with more prototypes, alot of consideration had to be made for the amount of panels that were in the garment. Due to the the method of sewing about .25 of an inch would be cut off on each end. This would make patterning the garment alot more difficult when having to add aesthetics such as mesh materials for gutting, stripes down the leg, cuffs on the end of the legs and the waistband on the top of the article.



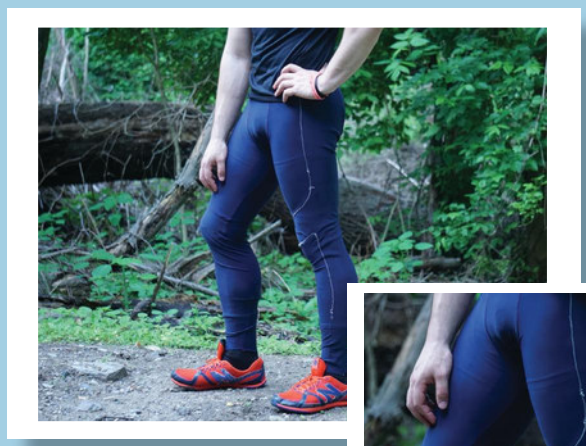
02

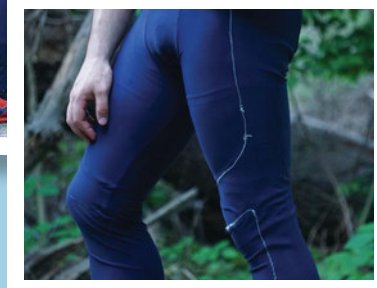
Stage 3: Feature Prototypes

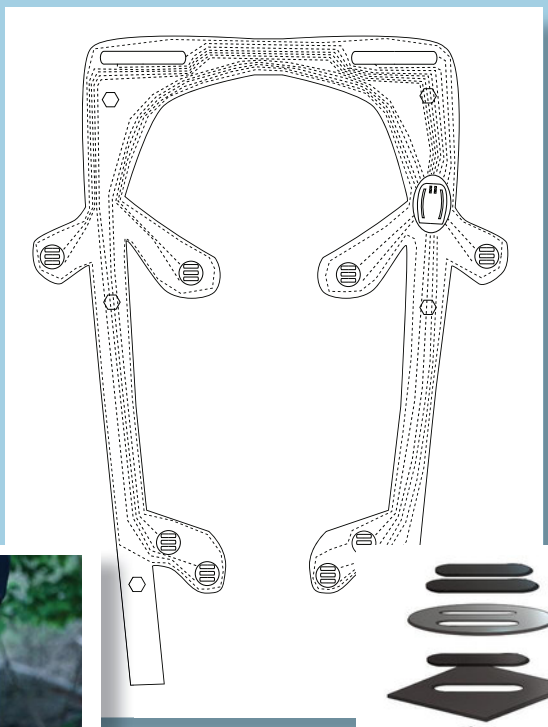
In addition to making the garment from scratch we had to add external and internal features that are not normally associated with knit base layers such as this. It was a challenge not only figuring out how to mount such features but also accounting for them in the patterning was also a learning curve in this development stage.



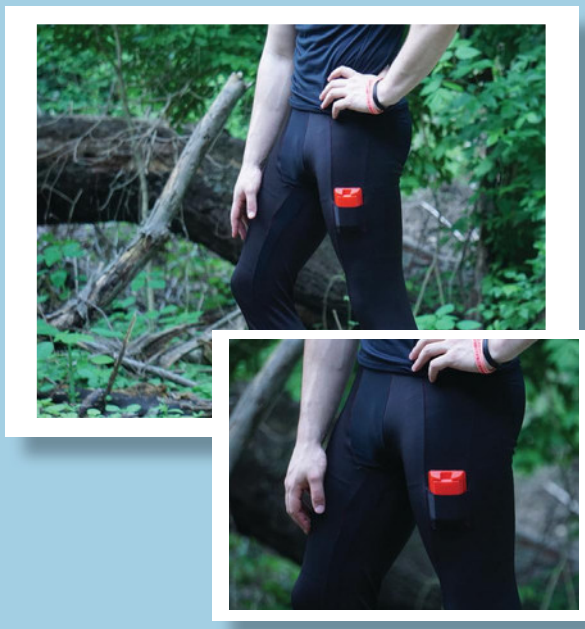
Feature 1 - Technology Wiring: This feature was a large nylon patch that was sewn into the body of the garment. The wiring and sensors had to be sandwiched between the garment material and the nylon patch with a fabric adhesive.

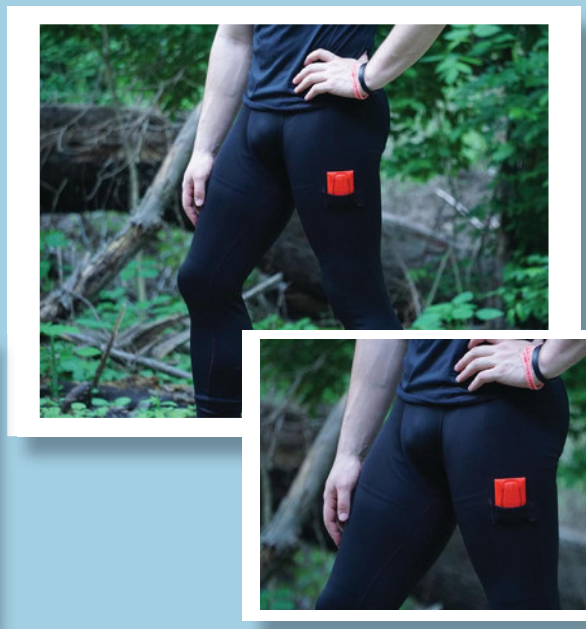






Feature 2 - Technology Module: We started out using 3D printed modules as a filler feature just, so we could get a feel for the size of the module and how it would fit onto the clothing.
Feature 3 - Motion Tile Pockets: In order for the Notch motion tiles to be integrated into the garment we sewed in quarter pockets so that w wouldn't need to use straps for the six motion tiles.

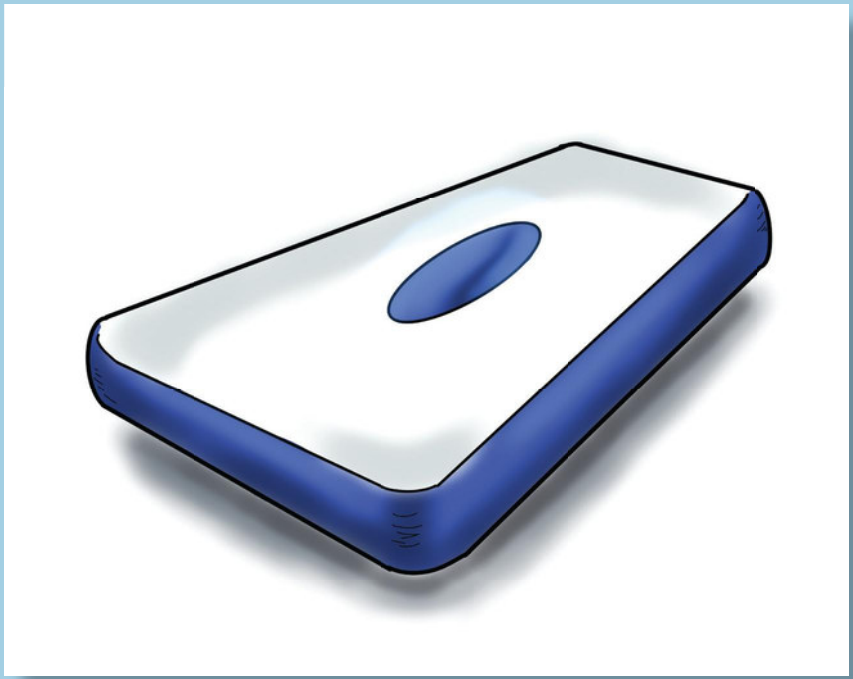




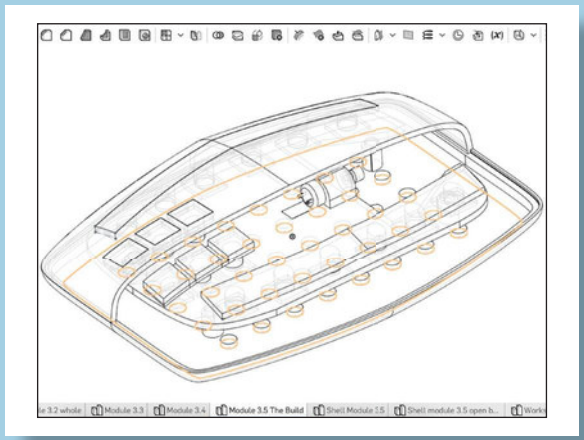
02

Stage 1: Design & Modeling

Our smart garment is a radical implementation of biometric sensory, but like all design, we took inspiration from other industries and current smart devices to define high value functions, such as users interface and user experience. Our design process involved physical design iterations to address the fit and feel of the device.



The wearable tech market has the challenge of designing an article of clothing that seamlessly and discretely puts cutting edge technology onto our body. This meant that the system needed to be minimal yet packed full of subtle details to maximize the user experience



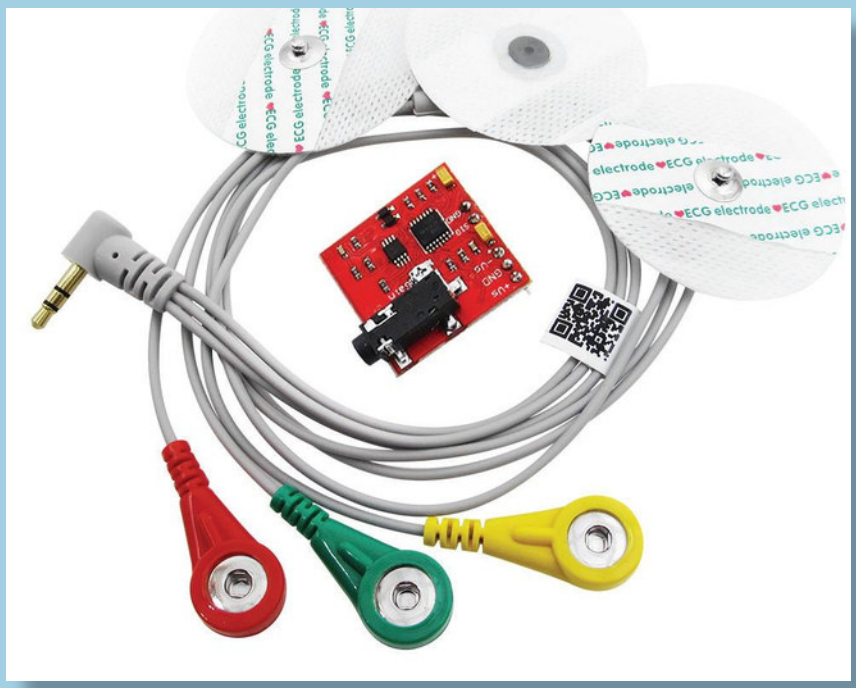
With basic dimensional constraints, we turned to rapid prototyping with an FDM printer for the module as well as a receiver component that would be integrated into the textile. We used clear resin in a SLA printer for the light pipes

The design process helped us identify and address topics such a the visible of the modules lights to the user and also the contoured shape of the receiver to better fit the hip.

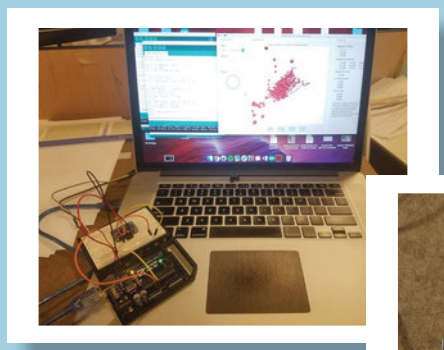
02

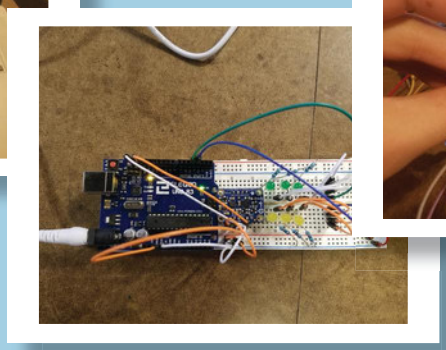
Stage 2: Technology Components

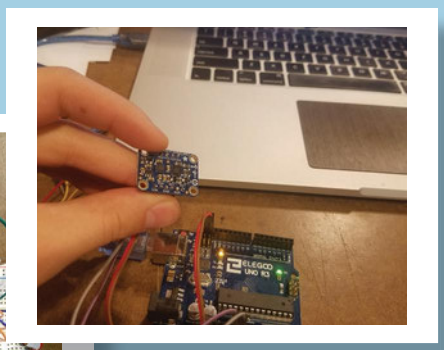
With our smart wearable, we imbedded as much on-board technology as we could including the EMG and motion sensors. The removable module is responsible for powering the system and sending data to the user party.



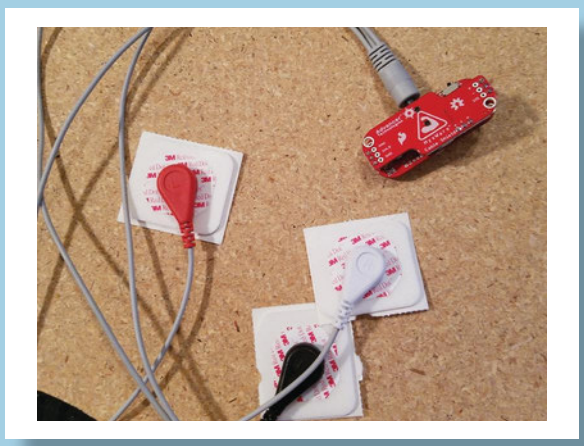
With the notion of enhanced user feedback we integrated lights that indicate the accuracy and strength readings from the sensors. Lights in addition to a vibration motor, alert to wearer to unsafe actions they might be performing.

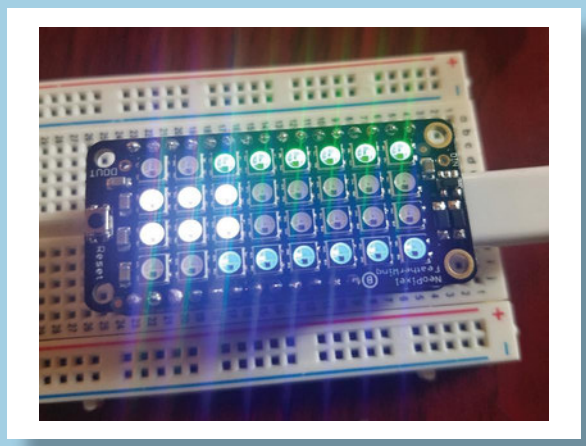






EMG sensors are used to monitor the output of specific muscle groups and ideal for re-balancing the body during recovery training.



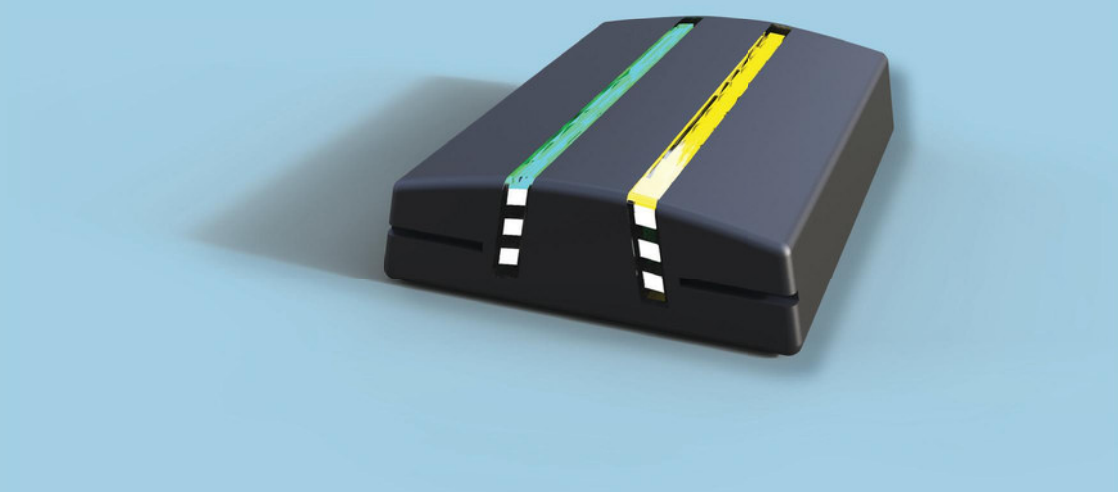


9dof motion sensors provide unrivaled real-time positioning of wearer. Our focus is on tracking body alignment to reduce the risk of injury from bad form or extraneous movement.

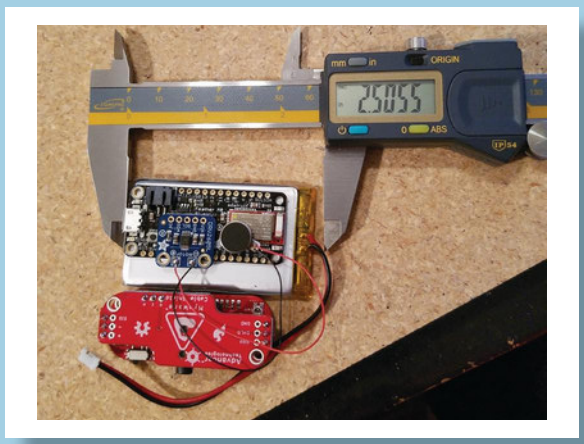
02

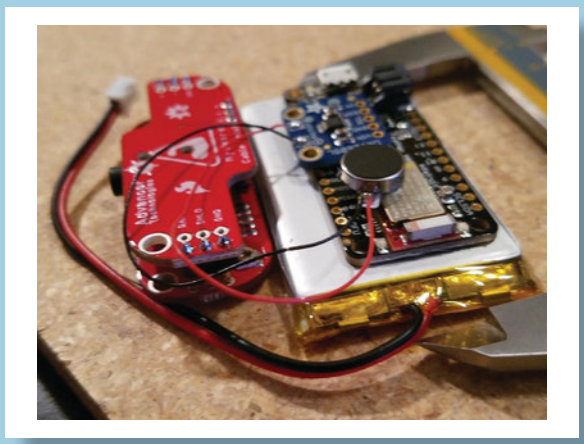
Stage 3: Manufacturing For Scale

While we utilized the ease of iterating with 3d modeling and printing, the production scope of the product requires a new set of variables. The removable module and receiver components would be made from reinforced nylon through the process of injection molding and polycarbonate would utilized for the lighting.



Internal sensors and electronics from wiring to the EMG and motion sensors would be off-the-shelf components, industry standards, that are made to be machine washable and wear resistant. The module would have a microchip and bluetooth module powered by the rechargeable LiPo battery.





The electronic connection points on the module facilitate both data and charging operations through rubber and metal contacts that correlate to pick-ups on the charging platform and the receiver within the garment.

The internal sensor system of the garment is comprised of wear and environmental resistant components but utilizes a layer of vinyl as barrier between the user's body and the wearable.

Section

03

Final Design

03

Final Design

Impulse is a smart garment system that utilizes Electromyography as well as motion capture technology to individually monitor and assist athletes recovering from debilitating sports injuries. With advanced data analytics at the heart of the system, we created a UI and UX platform that empowers the user and aid the specialist as a remote monitor and secondary spotter, to monitor progress and training.

03

System Specifications

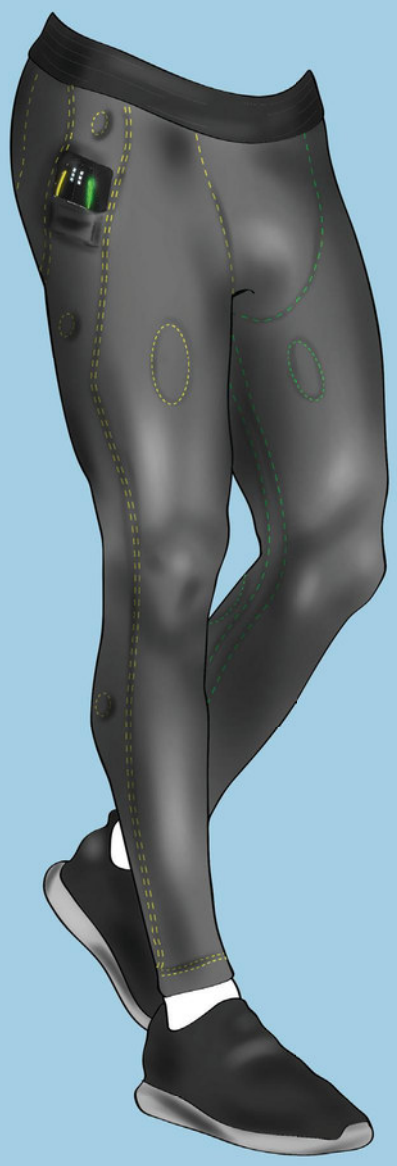
Sensors

6 Motion Trackers
(hip, knee, ankle)

12EMG
Inner Quad
OuterQuad
Glute
Hamstring
Gastrocnemius (calf)
Soleus (calf)

Machine washable on cold wash
and low heat dryer settings

Must remove power module



10+ hours of live tracking

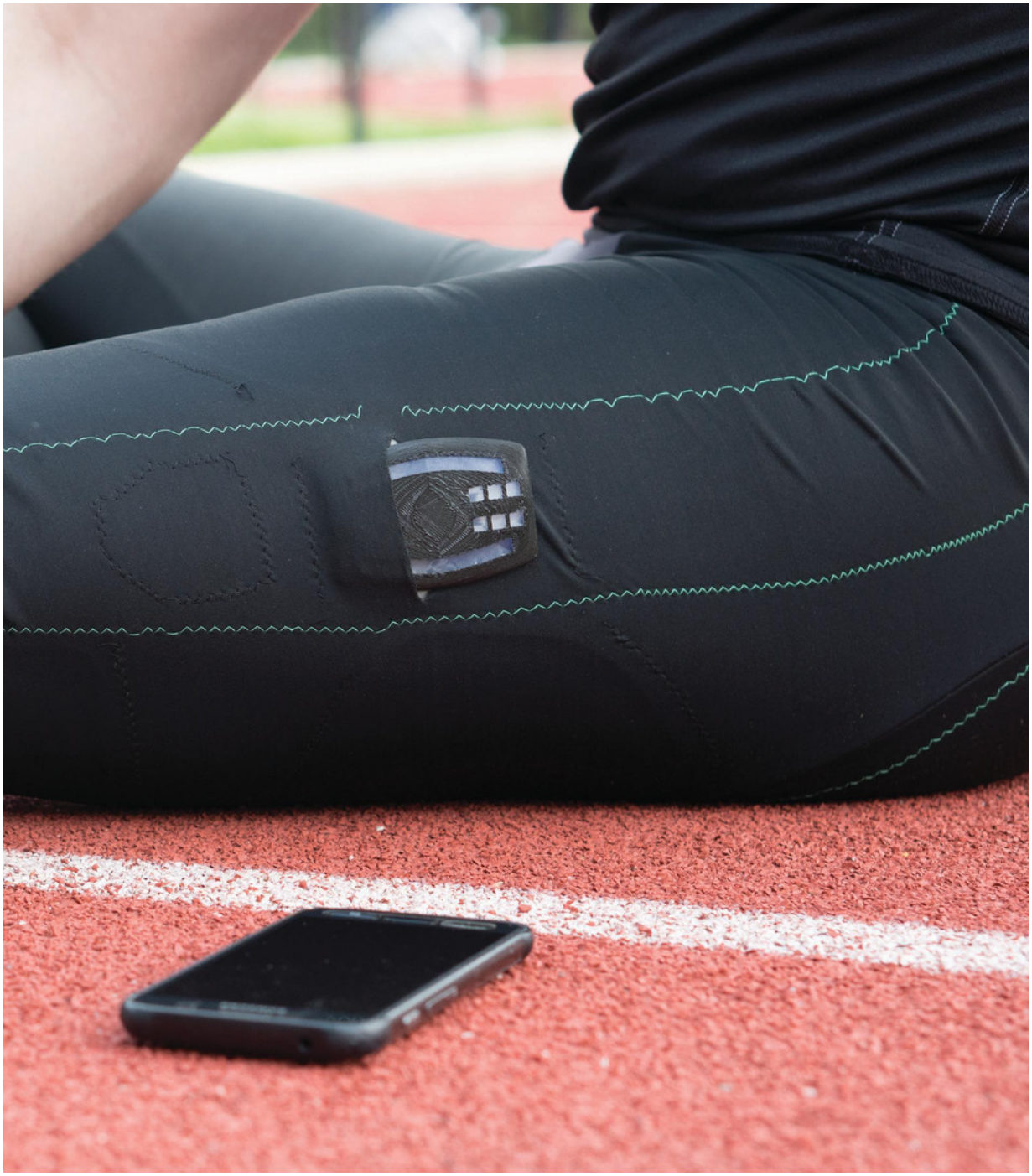
Wireless Connectivity

COMPATABILITY

Android mobile devices
iOS 11 & Windows 10
or newer respective platforms

03

03



03

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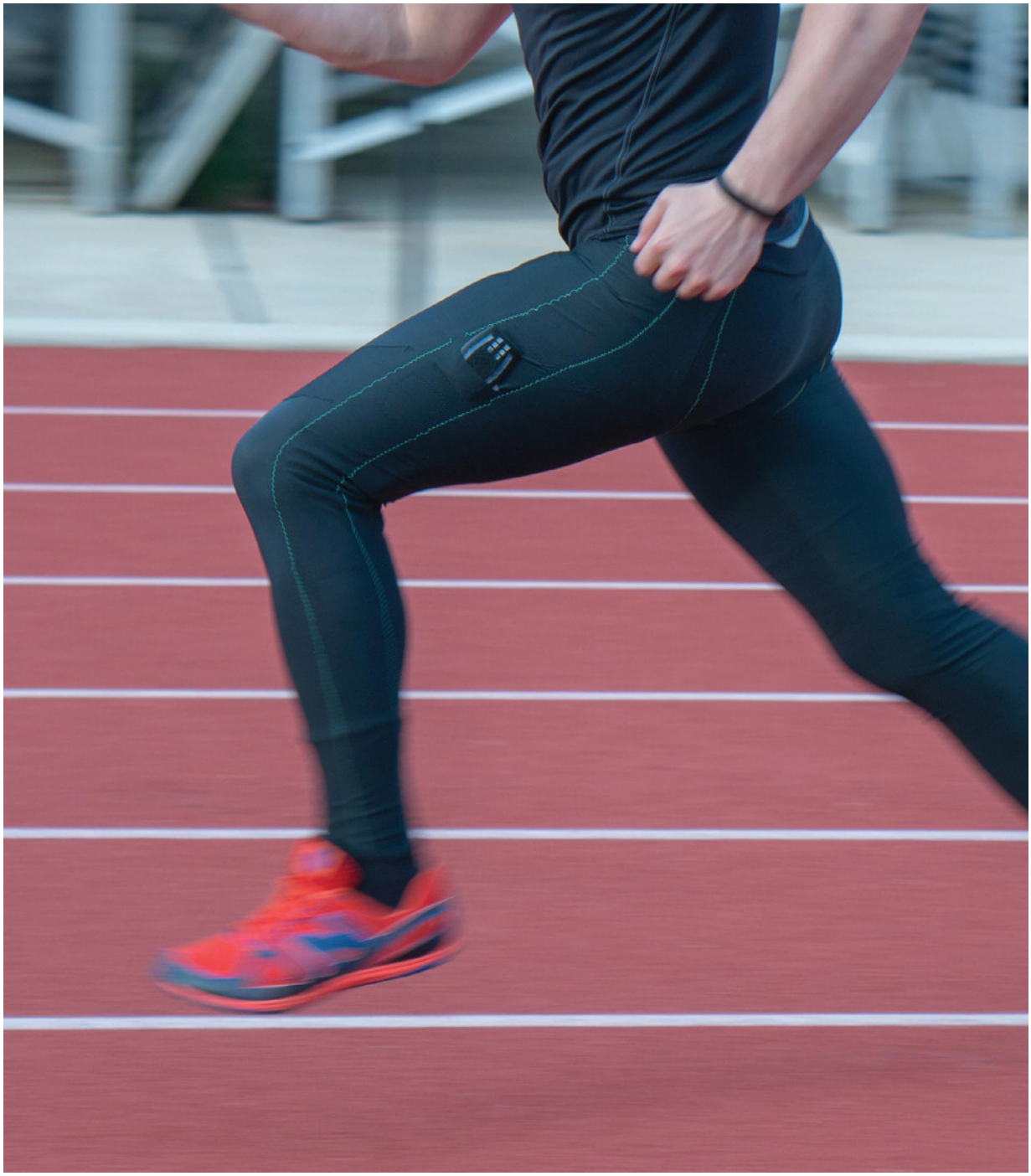


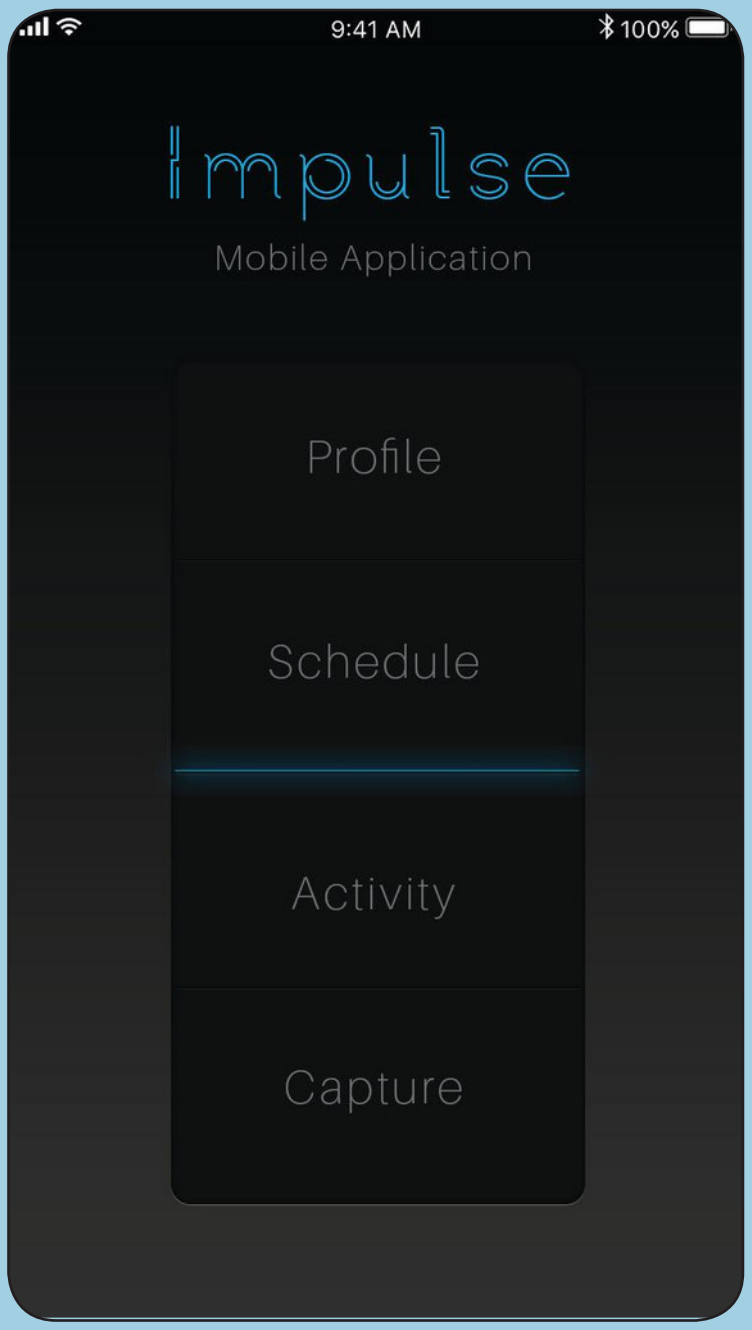
Section

04

Final System

04

Mobile App



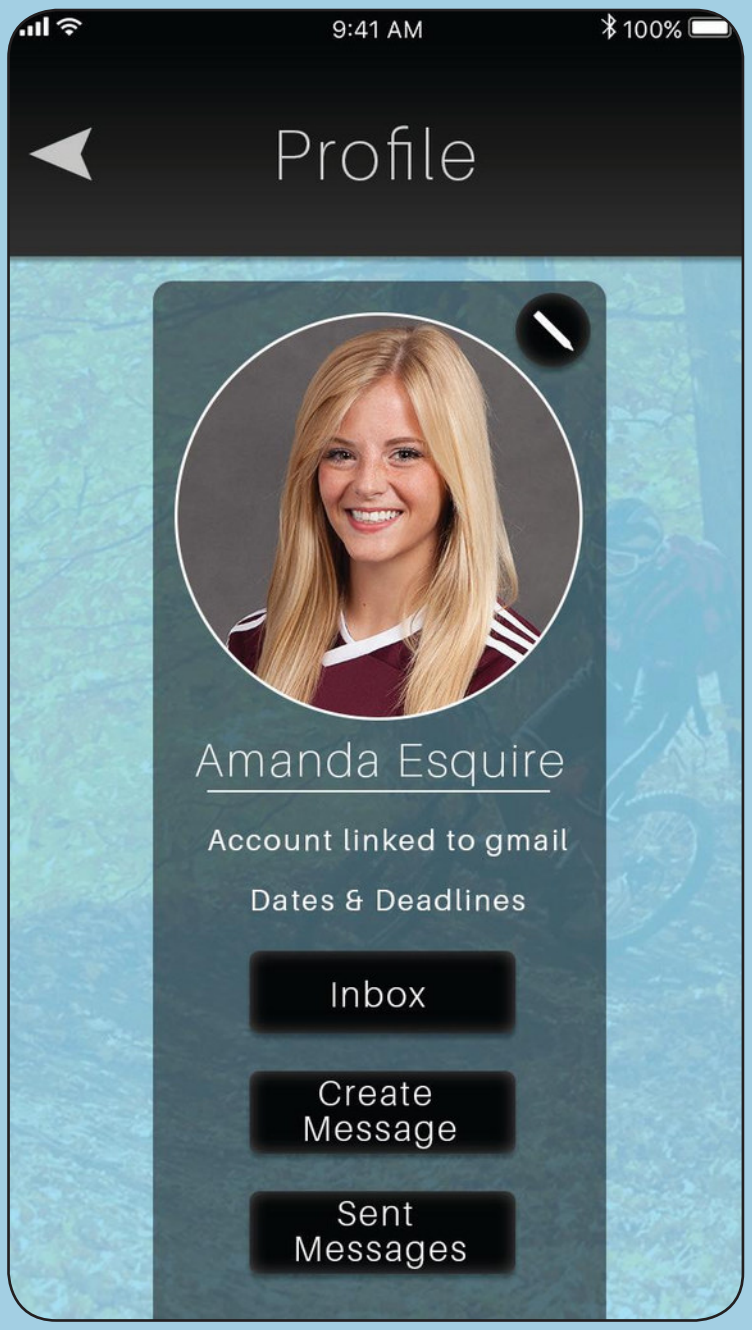
Impulse data base is accessible to all parties at any given time throughout the recovery process. The athlete interacts at face value with the system where physical therapists and trainers dive deeper to gain better insight regarding treatment. The universal first step for both sides is to sign in through the Impulse portal, unlocking the user specific features.

Desktop App


Impulse
Recovery for a new age.
Search...
Home
Profile
Schedule
Activity
Capture
Log
Recovery
doesn't have to
be a one man show.
Create Profile
Download
Desktop App
Download
Mobile App

04

Mobile Application

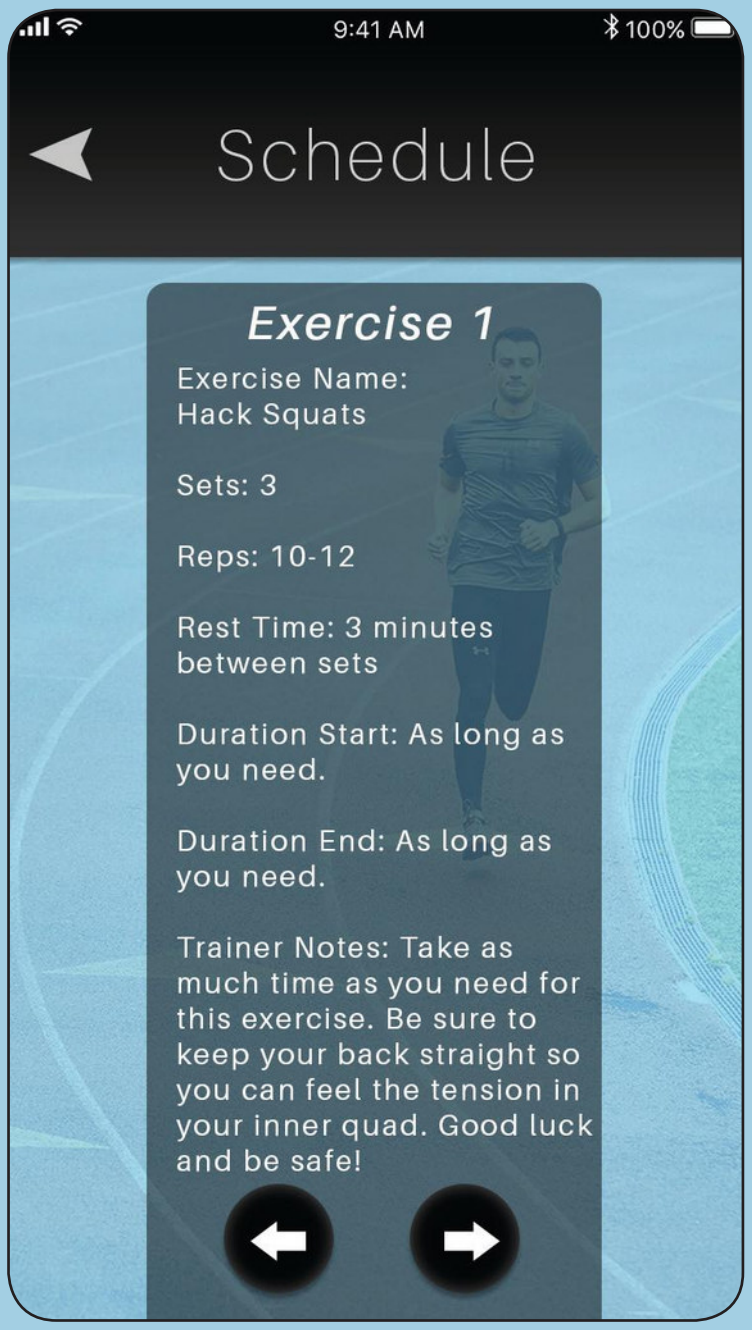


The functionality of the Athletes' user interface provides visualizers and body maps to render a coherent view of their progress during mobility and strength exercises. The specialist have access to the full potential of the sensors as they are adept and can interpret the raw data.

Desktop Application

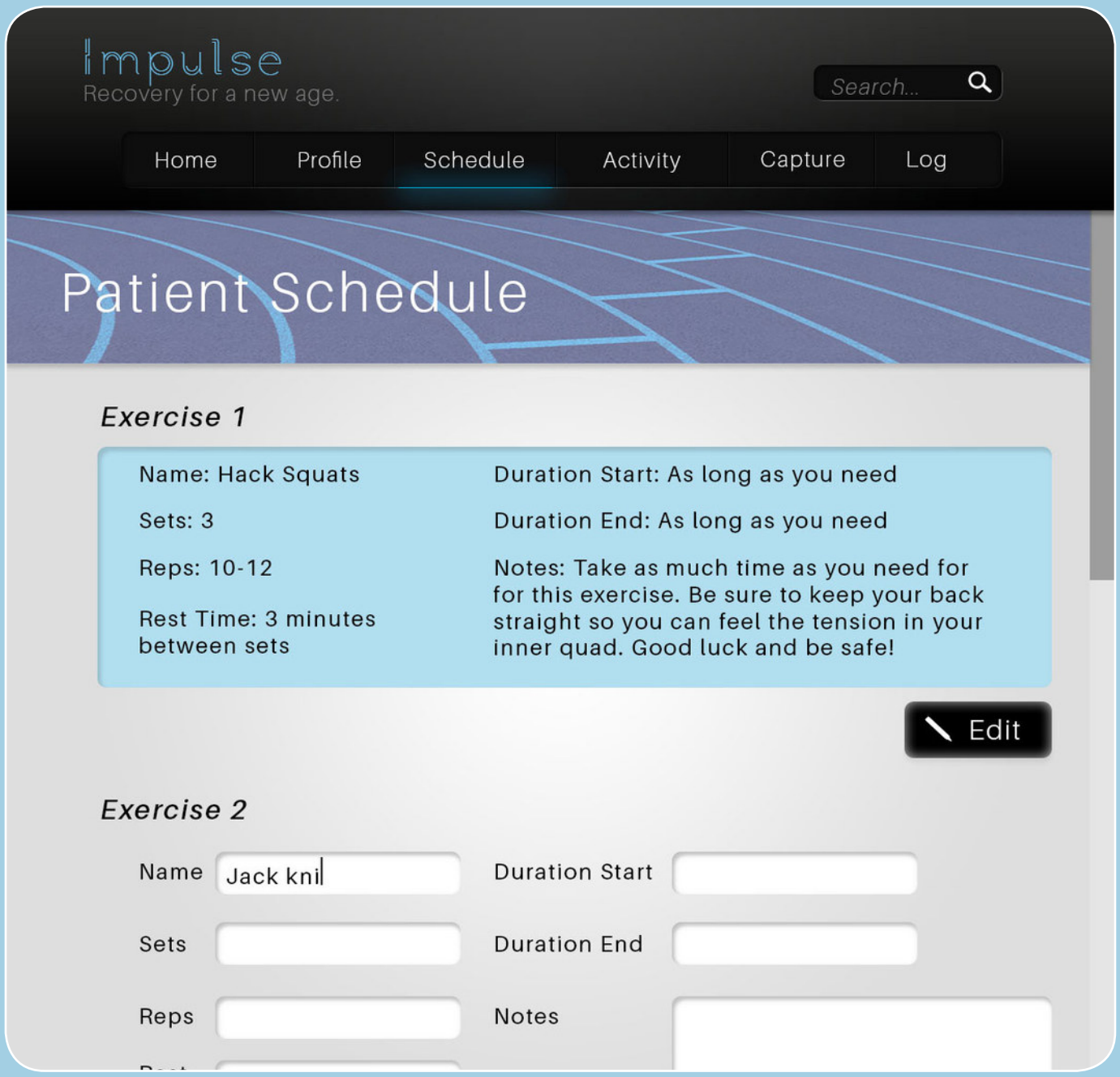
04

Mobile Application



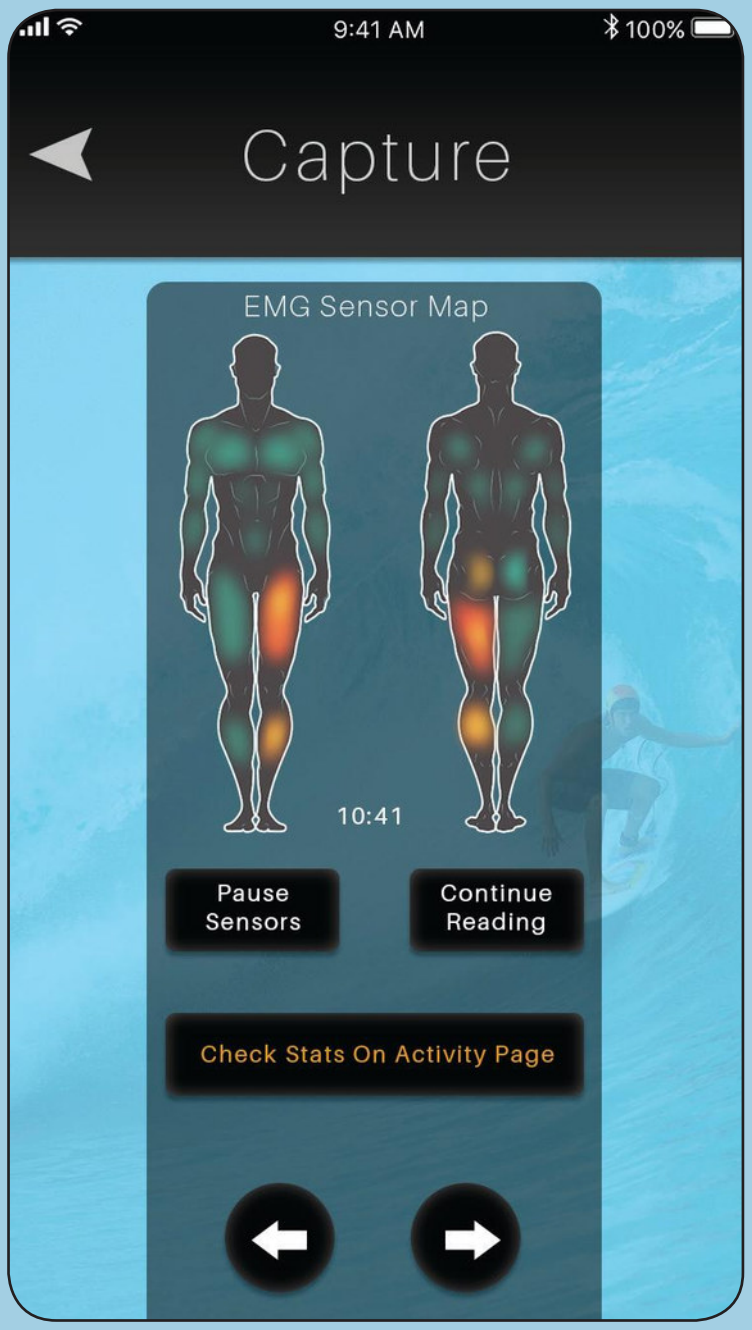
Each time the athlete signs in for another session, they can view their weekly schedule. These personalized routines are curated by their specialist and follow the speed at which the athlete is progressing based on prior performance and professional opinion.

Desktop Application



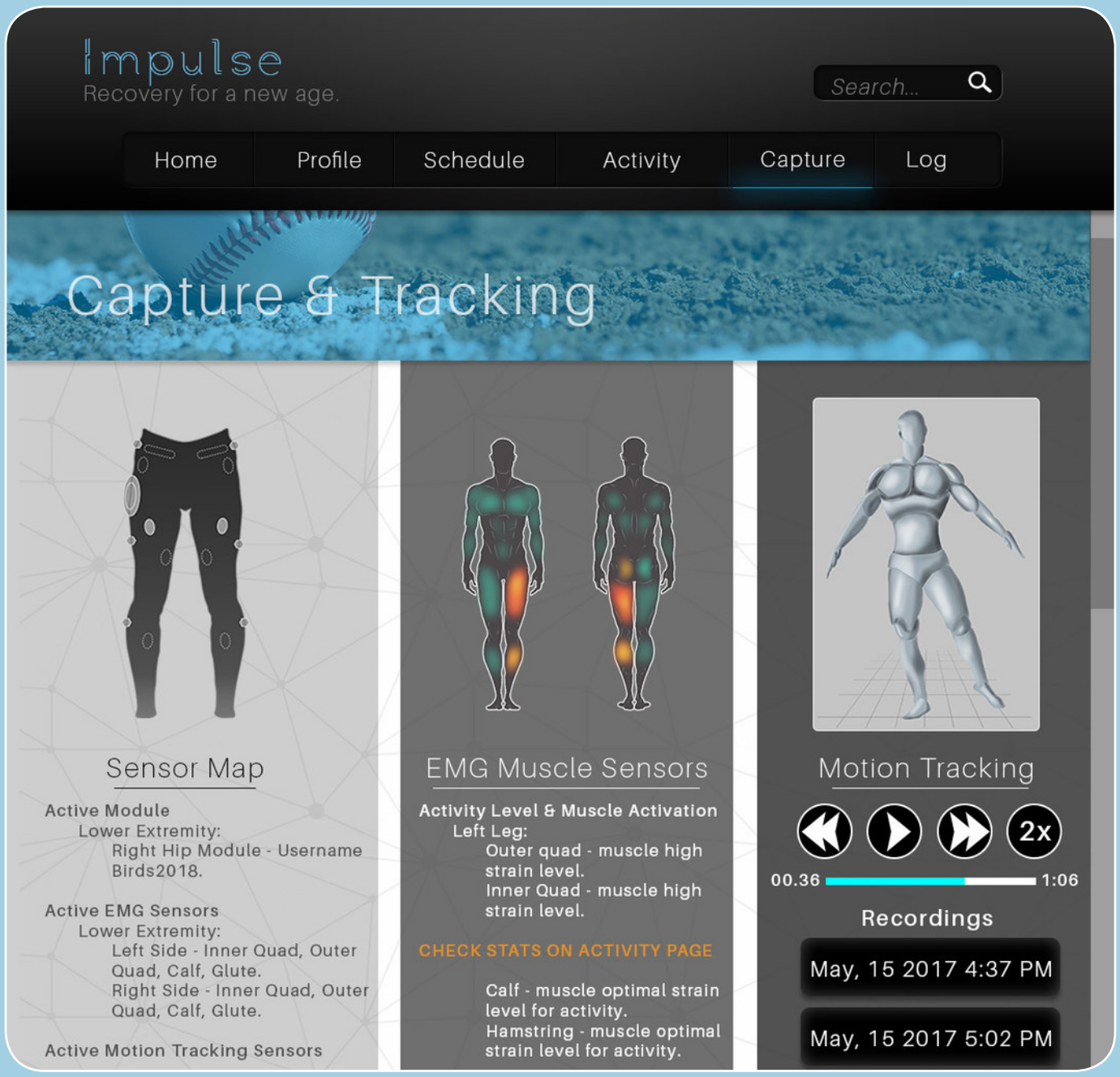
04

Mobile Application



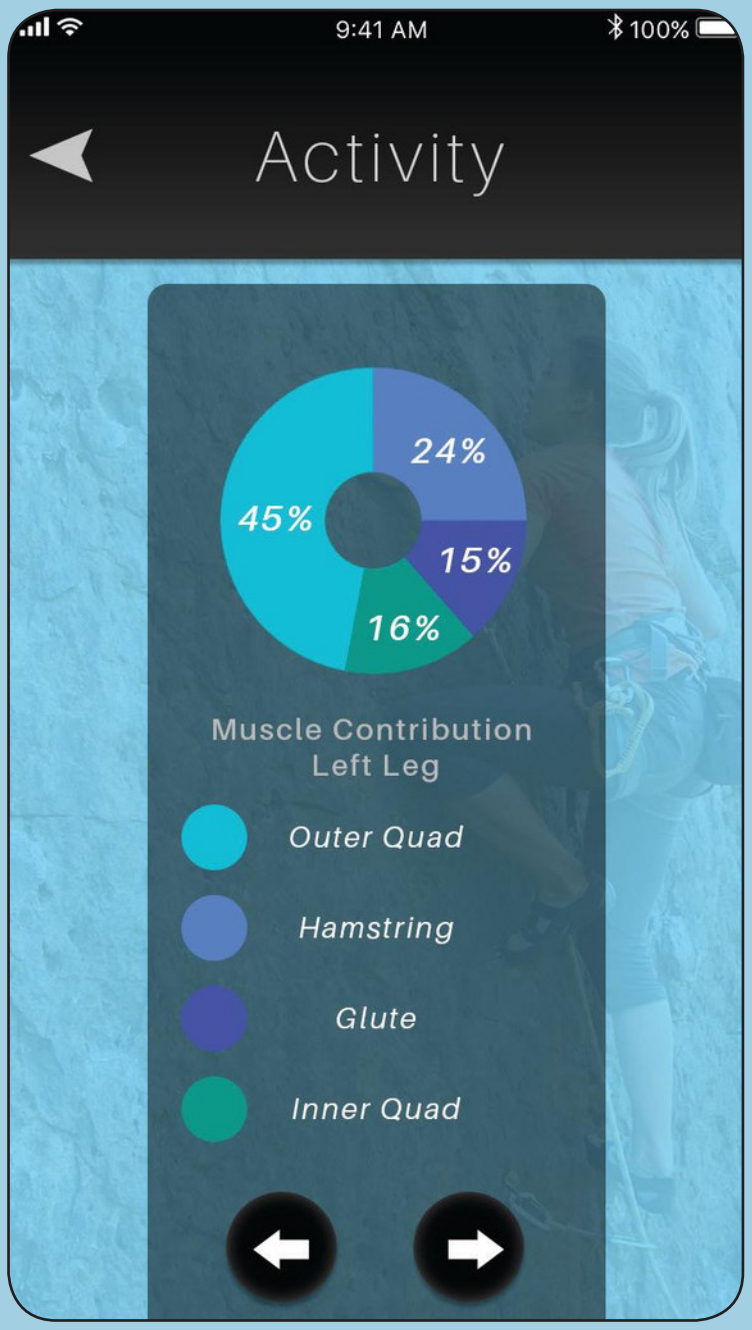
This feature provides real time visuals and reference ques during training sessions. The system alerts the user whenever there is a risk of injury or excessive movement made by the wearer. The enhanced feedback system of Impulse provides the user immediate feedback via visual and vibration ques on the garment with more information made accessible on the mobile app.

Desktop Application



04

Mobile Application



Activity logs show how the athletes' past performances vary from range of motion exercises to your muscle targeting weight training. Athletes benefit from having a reference point to work off of, and specialists have a meticulous records of each athlete' personal performances. Physical therapists can see precise readings such as, their clients running gait, and team trainers can compare max lift performance of consecutive workouts.

Desktop Application